Functional MRI of Scanner Acoustic Noise Induced Brain Activation

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Introduction:

A concern in functional MRI (fMRI) brain activation produced by acoustic noise accompanying the scanning process may corrupt some results. Regions that are always fully activated by scanner noise may not be modulated between "resting" and "active" states, and will therefore not appear as fully "activated" in fMRI brain activation maps. In this study, a method is introduced by which regions activated by the scanner noise are mapped.

Methods:

All studies were performed using echo planar imaging (EPI) on a Bruker Biospec 3T/60 scanner. A balanced torque three axis gradient coil and endcapped quadrature transmit receive RF coil were used. One to five imaging planes were collected. In-plane voxel dimensions = 3.8 x 3.8 x 10 mm. TE = 40 ms. TR = 0.5 to 1 sec. Flip angle = 60° to 80°. Four subjects were scanned. Two time series types were collected: A "task" time series involved first applying only EPI gradients, at the same TR used for imaging, for about 20 seconds without application of any RF power, then, without pause, starting the time series image collection. Images were collected for 20 to 40 seconds. A "control" time series involved the sequential acquisition of echo planar images in the same manner as the first time series, but without the prior 20 seconds of EPI gradient pulses. Several trials of each series were collected in an interleaved fashion and averaged to produce an average "task" and "control" time series. Each "control" image was subtracted from a "task" image at each corresponding point in time to produce a "difference" time series.

Results:

Figure 1 a shows two plots of the MRI signal from the same ROI in auditory cortex during the first 10 seconds of imaging. The time dependence of the MRI signal during its approach to steady state longitudinal magnetization was identical in the two time series, *except* in regions that had enhanced blood oxygenation level dependent (BOLD) contrast due to neuronal activation by the prior EPI gradient pulses. The fractional "difference" signal shown in Figure 1 b was used as a reference function to map activation by the EPI gradient pulses. Anatomical images and corresponding correlation maps are shown in Figure 2. Auditory cortex activation is demonstrated.

Figure 1

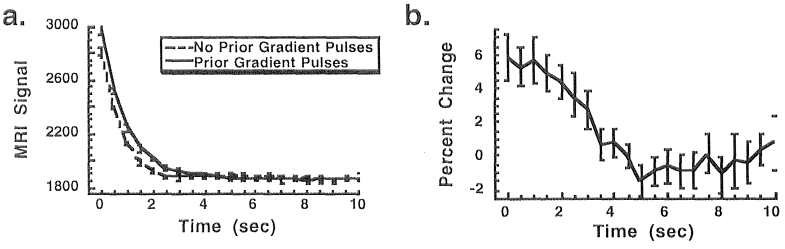

Figure 2

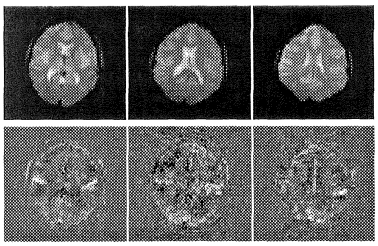

Figure 1: a) Auditory cortex MRI signal with and without prior gradient pulses. b) Fractional difference between the two plots in a. **Figure 2:** Anatomical images and corresponding correlation maps of activation produced by the scanner noise.

Conclusions:

Brain activation produced by the acoustic noise of EPI has been mapped. Future efforts in mapping of the tonotopic representation of the primary auditory cortex may benefit from paradigms designed to take scanner noise related activation into account. An example of a paradigm to use would be one that involves alternating between tone presentation and silence prior to starting each time series collection of images, then performance of analysis of the "difference" signal from the first 10 seconds of each of these two time series types.